L Number	Hits	Search Text	DB	Time stamp
13	429	257/778,780,786,730.ccls. and ((hole or recess or opening) same adhesive)	USPAT; US-PGPUB	2002/12/10 11:53
14	403	438/15,106-108,666.ccls. and ((hole or recess or opening) same adhesive)	USPAT; US-PGPUB	2002/12/10 11:05
15	393	(257/778,780,786,730.ccls. and ((hole or recess or opening) same adhesive)) not (438/15,106-108,666.ccls. and ((hole or recess or opening) same adhesive))	USPAT; US-PGPUB	2002/12/10 11:05
16	239	361/760,772,779,774.ccls. and ((hole or recess or opening) same adhesive)	USPAT; US-PGPUB	2002/12/10 11:56
17	212	(361/760,772,779,774.ccls. and ((hole or recess or opening) same adhesive)) not ((257/778,780,786,730.ccls. and ((hole or recess or opening) same adhesive)) not (438/15,106-108,666.ccls. and ((hole or recess or opening) same adhesive)))	USPAT; US-PGPUB	2002/12/10 11:56
18	202	((361/760,772,779,774.ccls. and ((hole or recess or opening) same adhesive)) not ((257/778,780,786,730.ccls. and ((hole or recess or opening) same adhesive)) not (438/15,106-108,666.ccls. and ((hole or recess or opening) same adhesive)))) not (438/15,106-108,666.ccls. and ((hole or recess or opening) same adhesive))	USPAT; US-PGPUB	2002/12/10 11:57
20	42	(under adj fill) same adhesive and semiconductor	USPAT; US-PGPUB	2002/12/10 13:10
21	2	(under adj fill) same adhesive and semiconductor	EPO; JPO; DERWENT; IBM_TDB	2002/12/10 13:11
22	5	((hole or opening or recess) with protrusions) same adhesive and semiconductor	EPO; JPO; DERWENT; IBM_TDB	2002/12/10 13:15
23	20	((hole or opening or recess) with protrusions) same adhesive and semiconductor	USPAT; US-PGPUB	2002/12/10 13:15

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TITLE: Process for mounting electronic device and semiconductor device

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An electronic device comprising a semiconductor chip which is fixed to the mounting face of a wiring board through an **adhesive** and in which external terminals are electrically connected with electrode pads of the wiring board through bump electrodes. **Recesses** are formed in the electrode pads, and in the **recesses** the electrode pads and the bump electrodes are connected. The electrode pads are formed over the surface of a soft layer, and the **recesses** are formed by elastic deformation of the electrode pads and the soft layer.

There is provided an electronic device comprising a semiconductor chip which is fixed to the mounting face of a wiring board through an **adhesive** and in which external terminals are electrically connected with electrode pads of the wiring board through bump electrodes, wherein there are formed **recesses** in the electrode pads, and in the **recesses** the electrode pads are connected to the bump electrodes. The electrode pads are formed on the surface of a soft layer, and the **recesses** are formed by elastic deformation of the electrode pads and the soft layer.

By this means, the clearance between the wiring board and the semiconductor chip can be narrowed to an extent corresponding to the

depth of the **recesses,**
thereby reducing the thickness of the **adhesive** sandwiched between the wiring
board and the semiconductor chip. As a result, the expansion of the **adhesive**
in the thickness direction can be suppressed, thereby preventing defective
connection between the electrode pads of the wiring board and the bump
electrodes during the temperature cycle test, and enhancing the reliability of
connection therebetween.

Between the external terminals 13 of the semiconductor chip 10 and the
electrode pads 4A of the wiring board 1, as shown in FIGS. 2 and 3, there are
interposed bump electrodes 15. These bump electrodes 15 are fixed to and
electrically and mechanically connected with the external terminals 13 of the
semiconductor chip 10 through the **openings** formed in the final passivation film
14 of the semiconductor chip 10. Moreover, the bump electrodes 15 are pressed
to and electrically and mechanically connected with the electrode pads 4A of
the wiring board 1 through the **openings** formed in the passivation film 5 of the
wiring board 1. The connection of the bump electrodes 15 by the press is
effected by the compressive force which are produced in the **adhesive** 16 by
thermal shrinkage and thermosetting shrinkage. In short, the semiconductor
chip 10 is mounted over the mounting face of the wiring board 1 by the FCA
method.

The thickness of the **adhesive** 16, interposed between the wiring board 1 and the
semiconductor chip 10, is defined by the clearance t2 between the wiring board
1 and the semiconductor chip 10. This clearance t2 is defined by the height of
the bump electrode 15 but is reduced by the depth t1 of the **recess** 4B because

the connection between the bump electrode 15 and the bump electrode 4A is effected in the **recess** 4B formed in the electrode pad 4A. In the electrode pad 4A of the wiring board 1, more specifically, there is formed the **recess** 4B in which the bump electrode 15 and the electrode pad 4A are connected, so that the clearance t2 between the wiring board 1 and the semiconductor chip 10 is narrowed to an extent corresponding to the depth t1 of the **recess** 4B. This makes it possible to reduce the thickness of the **adhesive** 16 interposed between the wiring board 1 and the semiconductor chip 10. As a result, the expansion of the **adhesive** 16, in the thickness direction, between the wiring board 1 and the semiconductor chip 10 can be reduced without reducing the height of the bump electrode 15.

Next, as shown in FIG. 7, the semiconductor chip 10 is bonded by thermocompression bonding using a heater 41 to press the electrode pads 4A by means of the bump electrodes 15, thereby forming the **recesses** 4B in the electrode pads 4A. Then the **adhesive** 16 is cured in this state. At this step, the clearance between the wiring board 1 and the semiconductor chip 10 is narrowed to an extent corresponding to the depth of the **recesses** 4B so that the thickness of the **adhesive** 16 sandwiched between the wiring board 1 and the semiconductor chip 10 is reduced. Since the **recesses** 4B are formed by the elastic deformation of the electrode pads 4A and the soft layer 3, moreover, the elastic forces of the electrode pads 4A and the soft layer 3 act upon the bump electrodes 15. By this step, the semiconductor chip 10 is mounted on the wiring board 1, as shown in FIG. 8.

There is provided an electronic device comprising a

semiconductor chip 10 which is fixed to the mounting face of a wiring board 1 through **adhesive** 16 and in which external terminals 13 are electrically connected with electrode pads 4A of the wiring board 1 through bump electrodes 15, wherein there are formed in the electrode pads 4A **recesses** 4B in which the electrode pads 4A and the bump electrodes 15 are connected. By this construction, the clearance t2 between the wiring board 1 and the semiconductor chip can be narrowed to an extent corresponding to the depth t1 of the **recesses** 4B, thereby reducing the thickness of the **adhesive** 16 sandwiched between the wiring board 1 and the semiconductor chip 10. As a result, the expansion of the **adhesive** 16 in the thickness direction can be reduced to prevent defective connection between the electrode pads 4A of the wiring board 1 and the bump electrodes 15 occurring during the temperature cycle test, enhancing the reliability of their connection.

Even if the bump electrodes 15 are moved upward by the expansion of the **adhesive** 16 in the thickness direction, moreover, the depth of the **recesses** 4B changes following up the movement of the bump electrodes 15, so that the connection between the electrode pads 4A and the bump electrodes 15 can be retained.

The present embodiment described is an example in which the wiring board 1 having the electrode pads 4A through the soft layer 3 is formed on the rigid board 2 and the **recesses** 4B are formed in the electrode pads 4A. As shown in FIG. 12 (a section), however, the construction may be the one that in a wiring board 19 having a rigid board, grooves 19A are formed in which the electrode

pads 4A are formed and connected with the bump electrodes 15. In this modification, the clearance between the wiring board 19 and the semiconductor chip 10 can be narrowed to an extent corresponding to the depth of the grooves 19, thereby reducing the thickness of the **adhesive** 16 sandwiched between the wiring board 19 and the semiconductor chip 10.

Between the external terminals 13 of the semiconductor chip 10 and the electrode pads 4A of the wiring board 1, there are sandwiched bump electrodes 15. These bump electrodes 15 are fixed to and electrically and mechanically connected with the external terminals 13 of the semiconductor chip 10 through the **openings** formed in the final passivation film 14 of the semiconductor chip 10. Moreover, the bump electrodes 15 are pressed against and electrically and mechanically connected with the electrode pads 4A of the wiring board 1 through the **openings** formed in the passivation film 5 of the wiring board 1. The connection of the bump electrodes 15 by the press contact is effected by the compression force which is produced in the **adhesive** 16 by thermal shrinkage and thermosetting shrinkage. In short, the semiconductor chip 10 is mounted over the mounting face of the wiring board 1 by the FCA method.

The thickness of the **adhesive** 16 sandwiched between the wiring board 1 and the semiconductor chip 10 is defined by the clearance between the wiring board 1 and the semiconductor chip 10. This clearance is defined by the height of the bump electrodes 15 but is reduced by the depth of the **recesses** 4B because the connection between the bump electrodes 15 and the bump electrodes 4A is effected in the **recesses** 4B formed in the electrode pads 4A. In the electrode pads 4A of the wiring board 1, more specifically, there is

formed the **recesses** 4B in which the bump electrodes 15 and the electrode pads 4A are connected, so that the clearance between the wiring board 1 and the semiconductor chip 10 is narrowed to an extent corresponding to the depth of the **recesses** 4B. This makes it possible to reduce the thickness of the **adhesive** 16 sandwiched between the wiring board 1 and the semiconductor chip 10. As a result, the expansion of the **adhesive** 16, in the thickness direction, between the wiring board 1 and the semiconductor chip 10 can be reduced without reducing the height of the bump electrode 15.

wherein said semiconductor chip is fixed to said wiring board through said plurality of bumps and an **adhesive** so that **recesses** are formed in said electrode pads, and said electrodes pads and said bumps are electrically connected in said **recesses**, and